G99/1-3 Type Test Verification Report

Inverter Model	GW12KN-DT,GW15KN-DT,GW17KN-DT,GW20KN-DT		
Manufacturer Reference number	2019041702		
Micro-generator technology	Grid-tied PV inverter		
Manufacturer name	Jiangsu GoodWe Power Supply Technology Co.,Ltd.		
Address	NO.189 Kun Lun Shan Road, Suzhou New District, Jiangsu, china		
Tel	+86 512 6239 7998	**Fax**	+86 512 6239 7972
E:mail	service@goodwe.com	**Web site**	http://www.goodwe.com
Maximum rated capacity	**Connection Option**		
	12	**kW three phase**	
	15	**kW three phase**	
	17	**kW three phase**	
	20	**kW three phase**	
Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above Type Tested reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G99.			
Signed	Jing Xie	**On behalf of**	Min Huang

The testing has been carried out by people with sufficient technical competency to carry out the tests.	
1. Operating Range: Two tests should be carried with the Power Generating Module operating at Registered Capacity and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence. Frequency, voltage and Active Powermeasurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating Module can operate within the required ranges for the specified period of time. The Interface Protection shall be disabled during the tests. In case of a PV Power Park Module the PV primary source may be replaced by a DC source. In case of a full converter Power Park Module (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source.	
Test 1 Voltage = 85% of nominal (195.5 V) Frequency = 47 Hz Power factor = 1 Period of test 20s	Result Pass
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Result Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result Pass
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result Pass

2. **Power Quality – Harmonics:** For Power Generating Modules of Registered Capacity of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12 The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. Power Generating Modules with emissions close to the limits laid down in BS EN 61000-3-12 may require the installation of a transformer between 2 and 4 times the rating of the Power Generating Module in order to accept the connection to a Distribution Network. For Power Generating Modules of Registered Capacity of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC G5.	**Pass**

Power Generating Module tested to BS EN 61000-3-12		
Micro-generator rating per phase (rpp)	kVA	Harmonic % = Measured

								Value (A) x 23/rating per phase (kVA)
	100% of rated output						Limit in BS EN 61000-3-12	
	L1		L2		L3			
	Measured Value (A)	%	Measured Value (A)	%	Measured Value (A)	%	1 phase	3 phase
2	0.183	0.63%	0.217	0.75%	0.283	0.98%	8%	8%
3	0.049	0.17%	0.018	0.06%	0.043	0.15%	21.6%	---
4	0.082	0.28%	0.092	0.32%	0.076	0.26%	4%	4%
5	0.077	0.27%	0.083	0.29%	0.037	0.13%	10.7%	10.7%
6	0.037	0.13%	0.030	0.10%	0.044	0.15%	2.67%	2.67%
7	0.095	0.33%	0.093	0.32%	0.097	0.33%	7.2%	7.2%
8	0.054	0.19%	0.056	0.19%	0.022	0.08%	2%	2%
9	0.029	0.10%	0.019	0.06%	0.020	0.07%	3.8%	---
10	0.015	0.05%	0.023	0.08%	0.035	0.12%	1.6%	1.6%
11	0.023	0.08%	0.078	0.27%	0.067	0.23%	3.1%	3.1%
12	0.028	0.10%	0.026	0.09%	0.026	0.09%	1.33%	1.33%
13	0.044	0.15%	0.079	0.27%	0.055	0.19%	2%	2%
THD	0.316	1.09%	0.334	1.15%	0.371	1.28%	23%	13%
PWHD	0.653	2.25%	0.655	2.26%	0.737	2.54%	23%	22%
	At 45-55% of rated output						Limit in BS EN 61000-3-12	
	L1		L2		L3			
	Measured Value (A)	%	Measured Value (A)	%	Measured Value (A)	%	1 phase	3 phase
2	0.189	0.65%	0.209	0.72%	0.288	0.99%	8%	8%
3	0.061	0.21%	0.025	0.09%	0.052	0.18%	21.6%	---
4	0.080	0.28%	0.088	0.30%	0.068	0.24%	4%	4%
5	0.075	0.26%	0.088	0.31%	0.030	0.10%	10.7%	10.7%
6	0.046	0.16%	0.027	0.09%	0.042	0.15%	2.67%	2.67%
7	0.091	0.31%	0.094	0.32%	0.103	0.36%	7.2%	7.2%
8	0.057	0.20%	0.048	0.17%	0.026	0.09%	2%	2%
9	0.028	0.10%	0.008	0.03%	0.028	0.10%	3.8%	---
10	0.024	0.08%	0.014	0.05%	0.036	0.12%	1.6%	1.6%
11	0.025	0.09%	0.069	0.24%	0.062	0.22%	3.1%	3.1%
12	0.027	0.09%	0.013	0.05%	0.028	0.10%	1.33%	1.33%
13	0.041	0.14%	0.073	0.25%	0.049	0.17%	2%	2%
THD	0.329	1.13%	0.345	1.19%	0.388	1.34%	23%	13%
PWHD	0.670	2.31%	0.705	2.43%	0.748	2.58%	23%	22%

3. Power Quality – Voltage fluctuations and Flicker: For Power Generating Modules of Registered Capacity of less than 75 A per phase (ie 50 kW) these tests should be undertaken in accordance with Annex A.7.1.4.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable Maximum Impedance. For Power Generating Modules of Registered Capacity of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC P28.	**Pass**

	Starting			**Stopping**			**Running**	
	d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	Pst	Plt 2 hours
Measured Values at test impedance	---	---	---	---	---	---	---	---
Normalised to standard impedance	0.05%	0.04%	0.04%	0.26%	0.06%	0.03%	0.0875	0.0875
Limits set under BS EN 61000-3-2	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	6.5

Applies to three phase and split single phase Micro-generators.

^ Applies to single phase Micro-generators and Micro-generators using two phases on a three phase system.

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the power factor of the generation output is 0.98 or above.

Normalised value = Measured value × reference source resistance/measured source resistance at test point × 3.68/rating per phase.

Single phase units reference source resistance is 0.4 Ω

Two phase units in a three phase system reference source resistance is 0.4 Ω.

Two phase units in a split phase system reference source resistance is 0.24 Ω.

Three phase units reference source resistance is 0.24 Ω.

Where the power factor of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the Standard Impedance.

The stopping test should be a trip from full load operation.

The duration of these tests need to conform to the particular requirements set out in the testing notes for the technology under test. Dates and location of the test need to be noted below.

4. Power quality. DC injection This test should be carried out in accordance with EN 50438 Annex D.3.10			**Pass**
Test level power	10%	55%	100%
Recorded value in Amps	0.035	0.045	0.031
As % of rated AC current	0.12%	0.15%	0.10%
Limit	0.25%	0.25%	0.25%

5. Power Quality. Power factor This test shall be carried out in accordance with EN 50538 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within ±1.5% of the stated level during the test.			**Pass**
	216.2 V	230 V	253 V
20% of Registered Capacity	0.9724	0.9757	0.9787

50% of Registered Capacity	0.9854	0.9856	0.9837
75% of Registered Capacity	0.9971	0.9982	0.997
100% of Registered Capacity	0.998	0.998	0.999
Limit	>0.95	>0.95	>0.95

6. Protection. Frequency test These tests should be carried out in accordance with the Annex A.7.1.2.3.						**Pass**
Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.49	20.36 s	47.7Hz / 25s	no trip
U/F stage 2	47 Hz	0.5 s	47	729 ms	47.2Hz / 19.98s	no trip
					46.8Hz / 0.48s	no trip
O/F stage 1	52 Hz	0.5 s	52	699 ms	51.8Hz / 89.98s	no trip
					52.2Hz / 0.48s	no trip
Note. For frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The “No trip tests” need to be carried out at the setting ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						

7. Protection. Voltage test These tests should be carried out in accordance with Annex A.7.1.2.2						**Pass**
Type A,B,C LV						
Ph1						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	184 V	2.5 s	183.18	2.91s	188V / 3.5s	no trip
					180V / 2.48s	no trip
O/V stage 1	262.2 V	1.0 s	261.2 V	1.15 s	258.2V 2.0s	no trip
O/V stage 2	273.7 V	0.5 s	272.7 V	824 ms	269.7V 0.98s	no trip
					277.7V 0.48s	no trip

Ph2						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	184 V	2.5 s	183.28	2.89s	188V / 3.5s	no trip
					180V / 2.48s	no trip
O/V stage 1	262.2 V	1.0 s	261.5 V	1.18 s	258.2V 2.0s	no trip
O/V stage 2	273.7 V	0.5 s	272.4 V	811 ms	269.7V 0.98s	no trip
					277.7V 0.48s	no trip

Ph3						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	184 V	2.5 s	183.55	2.93s	188V / 3.5s	no trip
					180V / 2.48s	no trip
O/V stage 1	262.2 V	1.0 s	261.6 V	1.19 s	258.2V 2.0s	no trip
O/V stage 2	273.7 V	0.5 s	272.9 V	829 ms	269.7V 0.98s	no trip
					277.7V 0.48s	no trip

Protection. Loss of Mains test

For PV Inverters shall be tested in accordance with BS EN 62116. Other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%, 55% and 100% of rated power.

For **Inverters** tested to BS EN 62116 the following sub set of tests should be recorded in the following table.

Test Power	33%	66%	100%	33%	66%	100%
Balancing load on islanded network	-5% Q Test 22	-5% Q Test 12	-5% P Test 5	+5% Q Test 31	+5% Q Test 21	+5% P Test 10
Trip time. Limit is 0.5s	0.386	0.423	0.417	0.428	0.433	0.395

For other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%, 55% and 100% of rated power. the following sub set of tests should be recorded in the following table

For Multi phase Micro-generators confirm that the device shuts down correctly after the removal of a single fuse as

well as operation of all phases.						
To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Registered Capacity	95% of Registered Capacity	95% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity	105% of Registered Capacity
Trip time. Ph1	NA	NA	NA	NA	NA	NA
Trip time. Ph2	NA	NA	NA	NA	NA	NA
Trip time. Ph3	NA	NA	NA	NA	NA	NA
Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies						

Protection – Frequency change, Vector Shift Stability test: This test should be carried out in accordance with EREC G98 Annex A1 A.1.2.6 (Inverter connected) or Annex A2 A.2.2.6 (Synchronous).			**Pass**
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49Hz	+50 degrees	no trip
Negative Vector Shift	50.5Hz	- 50degrees	no trip

Protection – Frequency change, RoCoF Stability test: The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (Inverter connected) or Annex A2 A.2.2.6 (Synchronous).			**Pass**
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95Hz/sec	2.1 s	no trip
51.0 Hz to 49.0 Hz	-0.95Hz/sec	2.1 s	no trip
Ramp range	Test frequency ramp:	Trip time limit	Trip time
49.0 Hz to 51.0 Hz	+1Hz/sec	0.5s	0.84s
51.0 Hz to 49.0 Hz	-1Hz/sec	0.5s	0.86s

9. Limited Frequency Sensitive Mode – Overfrequency test: This test should be carried out in accordance with EN 50438 Annex D.3.3 Power response to over- frequency. The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. Above 50.9Hz ,the slope should be above 0.5%Pmax/s.				**Pass**
Test sequence at Registered Capacity >80%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	20168	50	20546	
Step b) 50.45 Hz ±0.05 Hz	19950	50.45	20511	21.62%

Step c) 50.70 Hz ±0.10 Hz	18895	50.7	20601	21.04%
Step d) 51.15 Hz ±0.05 Hz	16921	51.15	20620	21.47%
Step e) 50.70 Hz ±0.10 Hz	18900	50.7	20690	20.96%
Step f) 50.45 Hz ±0.05 Hz	19992	50.45	20638	17.45%
Step g) 50.00 Hz ±0.01 Hz	20257	50	20695	
Above 50.9Hz slope				6.12%
Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01 Hz	10105	50	10291	
Step b) 50.45 Hz ±0.05 Hz	10008	50.45	10279	18.81%
Step c) 50.70 Hz ±0.10 Hz	9483	50.7	10007	20.46%
Step d) 51.15 Hz ±0.05 Hz	8513	51.15	10527	20.98%
Step e) 50.70 Hz ±0.10 Hz	9523	50.7	10007	19.14%
Step f) 50.45 Hz ±0.05 Hz	9994	50.45	10277	21.58%
Step g) 50.00 Hz ±0.01 Hz	10108	50	10292	
Above 50.9Hz slope				6.54%

10. Protection. Re-connection time				**Pass**
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1.				
Time delay setting				
Measured delay time(s)	At 258.2V	At 204.1V	At 47.6Hz	At 51.9Hz
	51.65s	51.78s	51.24s	51.99s
Confirmation that the SSEG does not re-connect	At 266.2V	At 196.1V	At 47.4Hz	At 52.1Hz
	no reconnection	no reconnection	no reconnection	no reconnection

11. Fault level contribution: These tests shall be carried out in accordance with EREC G98 Annex A1 A.1.3.5 (Inverter connected) and Annex A2 A.2.3.4 (Synchronous).		**Pass**
For Inverter output		
Time after fault	Volts	Amps
20ms	15.2V	331mA
100ms	14.5V	300mA
250ms	13.5V	320mA
500ms	12.8V	336mA
Time to trip	0.0619	In seconds

12. Self-Monitoring solid state switching: No specified test requirements. Refer to Annex A.7.1.7.	
It has been verified that in the event of the solid state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	N/A

13. Wiring functional tests: If required by para 15.2.1.	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of	N/A

commissioning)	

14. Logic Interface (input port).	
Confirm that an input port is provided and can be used to shut down the module.	Pass

Additional comments
GW12KN-DT, GW15KN-DT, GW17KN-DT is similar to GW20KN-DT in circuit and construction except for output rating of current and power. The test result can refer to GW20KN-DT .